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BUREAU OF FISHERIES

Fishery Circular No. 2. Issued June, 1931

REVIEW OF THE FISH-FARMING INDUSTRIES OF THE UNITED STATES[1]

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INTRODUCTION

During the past century the increased interest in depletion of fisheries in the United States has been attended by a corresponding increase of interest in fish farming. The demand for game fishes has caused State and Federal Governments, as well as sportsmen's organizations and individuals, to apply concerted efforts to rehabilitate our waters. This growth has been attended by increasing knowledge that has revealed the opportunities in raising fish for market.

The commercial fish-farming activities in the United States may be divided into three divisions: The trout industry, the pond-fish industry, and the goldfish industry. Believing that these industries were adding materially to the economic welfare of the United States, surveys were made of them by the Bureau of Fisheries in order to ascertain their importance. The report on the goldfish industry by Quast (1929) has already been published. The information in the report on the trout and pond fish industries is based on the findings of the writer as obtained in a personal canvass which was conducted

[1] Approved for publication Feb. 16, 1931.

during the months from September to December, 1930, and which covered representative establishments in all sections of the United States. In addition, questionnaires were sent to all establishments engaged in the trout and pond fish industries, whose names were on record with the bureau, to obtain figures on the scope of their operations.

The writer wishes to express his appreciation for the cooperation received from members of the trout and pond fish industries in supplying information and answering the questionnaires.

FISH-FARMING INDUSTRIES IN THE UNITED STATES

TROUT AND POND FISH INDUSTRIES

The trout industry includes the farming of charrs and trouts. It had its inception in 1864, when Seth Green started a hatchery at

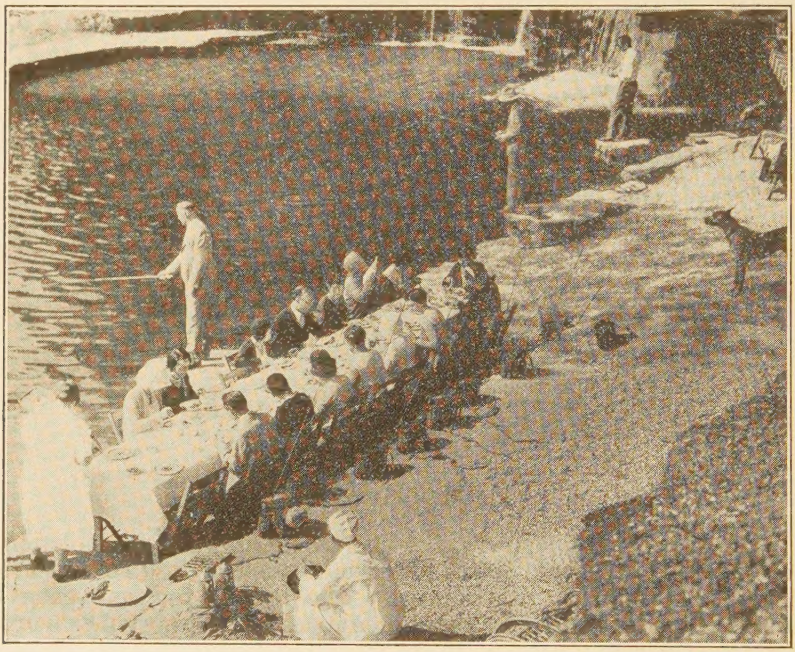

FIGURE 1.—At establishments such as shown in this picture, regular fish dinners are served. Customers may here both catch and eat their trout

Caledonia Springs, N. Y. (Milner, 1874). Artificial impregnation and hatching of trout had been accomplished, however, as early as 1804, when this was done successfully by the Rev. John Bachman of Charleston, S. C. (Slack, 1872). The pond-fish industry includes the farming of basses, sunfish, crappie, and catfish. The writer has been unable to determine from any records the year of inception of this industry, but from personal interviews with the culturists in the industry, it was probably during the year 1900 that the first pond-fish establishment was founded.

The early development of the trout industry was confined to the eastern part of the United States, where scarcity of fish for sport fishing was first noticed and which forced the States to make regulations prohibiting the sale of wild game fish.

Species cultivated.—Trouts produced: Brook trout or "speckled trout," *Salvelinus fontinalis;* rainbow trout, *Salmo irideus;* cutthroat trout, *Salmo lewisi;* brown trout, *Salmo fario;* Loch Leven trout, *Salmo levenensis;* lake trout, *Cristivomer namaycush;* and landlocked salmon, *Salmo salar sebago.* Pond fish produced: Largemouth black bass, *Micropterus salmoides;* smallmouth black bass, *Micropterus dolomieu;* crappie, *Pomoxis annularis* and *P. sparoides;* Bluegill sunfish, *Lepomis incisor;* and catfish or bullhead, *Ameiurus nebulosus.*

All of these trouts and pond fishes, except the brown and the Loch Leven trouts, are native to waters in the United States. Loch Leven trout eggs were first received in this country in 1884, at which time brown trout, which were introduced from Germany, were already established in eastern American waters.

Each of these species of trouts and pond fishes was confined in range by natural barriers, such as mountains and deserts, and by the limited existence of favorable waters. Through extensive shipments of live eggs and fish, however, the ranges of these species have been greatly increased, and each may now be found in most of the suitable waters in the United States.

Geographical extent.—Geographically, the trout industry is confined to localities where cold-water supplies are available. Pond fish require warmer water than do trout. Thus, while trout raising is confined mainly to the northern half of the United States, commercial pond-fish raising extends as far south as Oklahoma and southern California. In addition to natural restrictions, legal restrictions are quite numerous, and the recommendation is made to anyone contemplating going into either the trout or the pond fish industry that information concerning such regulations be solicited from State officials.

In showing figures on production and distribution, the United States has been divided into three sections, which are called the Eastern Section, the Central Section, and the Western Section. The Eastern Section includes the States of Maine, Massachusetts, New York, Rhode Island, Connecticut, and Pennsylvania. The Central Section includes Wisconsin, Michigan, Minnesota, North Dakota, Nebraska, Missouri, and Oklahoma. The Western Section includes Colorado, Wyoming, Utah, Montana, Idaho, Washington, Oregon, and California. From the standpoint of production and distribution, Massachusetts, Pennsylvania, and New York are the States most important in the Eastern Section, while Colorado is the only outstanding State in the rest of the country.

In 1929 there were 133 [2] establishments engaged in the trout industry. These employed 253 persons, exclusive of proprietors, who were paid $271,088 in salaries and wages, and used 5,969 acres of ponds in their operations. The pond-fish industry engaged 9 persons, exclusive of proprietors, who were paid $6,450 in salaries and wages for 11 establisbments, which used 638 acres of ponds in production.

Approximately half of the total acreage of water used for trout was in Colorado, where, in certain localities, natural lakes are utilized. In these lakes the trout fry are planted in the spring, and from then on the culturist exercises no control over the trout, except in feeding artificial foods. Fish for food are caught in gill nets or by hook and line, and eggs are taken when the adult fish "run" in the creeks tributary to these lakes.

[2] A list of establishments engaged in raising trout and pond fish (corrected to Jan. 1, 1931) may be obtained from the Bureau of Fisheries.

In other parts of Colorado and in most of the rest of the United States, where fish culture is practiced, trout are retained in inclosures where they are fed, graded as to size, treated for disease, and kept under direct observation at all times.

Production.—During 1929, trout farmers of the United States produced 231,141,721 eggs, of which 171,093,444 were spawned from brook trout. The remainder were from rainbow, cutthroat, and brown trout. A large part of these eggs were sold to sportsmen and to State and Federal Governments. No pond-fish eggs are shown in the tables since they are allowed to hatch naturally, and thus operations are largely uncontrolled by the fish-culturist. The production of fry numbered 32,258,742, consisting mainly of brook and rainbow trout. The production of largemouth black bass fry amounted to 429,400. Large numbers of fry were sold to sportsmen and to State and Federal Governments.

In 1929, 9,475,467 adults were produced, and the greater part of this number consisted of brook and rainbow trout.

Brook trout is the most important species cultivated in the Eastern Section, while rainbow trout have proven most popular in the Central and Western Sections. Brown trout are cultivated to a small degree in all three sections, as are black bass. Production of cutthroat trout is important only in the Western Section.

TABLE 1.—*Production of the trout and pond fish industries in the United States, 1929*

Species	Eggs			Fry and fingerlings		
	Eastern Section	Central Section	Western Section	Eastern Section	Central Section	Western Section
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
Brook trout	137, 856, 444	6, 147, 000	27, 090, 000	8, 458, 000	657, 300	8, 529, 450
Rainbow trout	6, 095, 300	5, 875, 000	38, 331, 000	522, 925	1, 131, 000	9, 548, 000
Brown trout	850, 500	2, 381, 000	50, 000	407, 317	140, 000	20, 000
Cutthroat trout		170, 000	6, 195, 477		25, 000	1, 313, 500
Miscellaneous trout [1]	100, 000			226, 500	25, 000	101, 000
Largemouth black bass					169, 400	260, 000
Miscellaneous pond fish [2]				63, 150	13, 200	648, 000
Total	144, 902, 244	14, 573, 000	71, 666, 477	9, 677, 892	2, 160, 900	20, 419, 950

Species	Yearlings and adults			Total		
	Eastern Section	Central Section	Western Section	Eggs	Fry and fingerlings	Yearlings and adults
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
Brook trout	1, 944, 013	230, 921	2, 390, 207	171, 093, 444	17, 644, 750	4, 565, 141
Rainbow trout	69, 734	373, 450	3, 130, 575	50, 301, 300	11, 201, 925	3, 573, 759
Brown trout	95, 231	57, 000	1, 000	3, 281, 500	567, 317	153, 231
Cutthroat trout		1, 000	301, 350	6, 365, 477	1, 338, 500	302, 350
Miscellaneous trout [1]	8, 950	10, 000		100, 000	352, 500	18, 950
Largemouth black bass		1, 516	250, 000		429, 400	251, 516
Miscellaneous pond fish [2]	2, 020		608, 500		724, 350	610, 520
Total	2, 119, 948	673, 887	6, 681, 632	231, 141, 721	32, 258, 742	9, 475, 467

[1] Includes lake trout, landlocked salmon, Loch Leven trout, grayling, and silver trout.
[2] Includes smallmouth black bass, crappie, bluegill sunfish, pickerel, catfish, and yellow perch.

Large differences may be noted in the numbers of eggs, fry, and adults produced in 1929. This is due to the fact that all of the products are not from the same year's activities. Most of the eggs

taken in 1929 were spawned from October through December of that year. The fry and fingerlings produced in 1929 were hatched largely from eggs taken in the latter part of 1928, and the yearlings and adults produced in 1929 had developed largely from the fry, fingerlings, and yearlings of 1928. Thus, no direct correlation can be shown between the numbers of eggs, fry, and adults produced in any one year, and the figures collected in the survey can not be tabulated so as to show losses incurred in hatchery operation.

Distribution.—Products marketed by the trout industry in the United States in 1929 had a combined value of $1,072,700. These products were composed of eggs valued at $214,197, fry and fingerlings at $67,243, yearlings and adults for stocking at $202,446, and adults for food at $588,814. Pond-fish products marketed were valued at $21,444 and were composed of fry and fingerlings valued at $20,062, yearlings and adults for stocking at $642, and adults for food at $740. These values have been calculated on the selling prices at the point of production.

In 1929 the commercial trout hatcheries in the United States sold 161,835,728 eggs valued at $214,197. This includes 122,732,269 brook-trout eggs valued at $139,387, 35,072,500 rainbow-trout eggs valued at $67,372, 2,355,482 brown-trout eggs valued at $4,070, and 1,675,477 cutthroat-trout eggs valued at $3,368. The majority of the brook, the brown, and the cutthroat-trout eggs were sold to State and Federal Governments, while the majority of the rainbow-trout eggs were sold to private hatcheries. Sportsmen bought a small amount of both brook and rainbow trout eggs. Brook-trout eggs predominated among those handled in the Eastern Section. The eggs handled in the Central Section were from brook, rainbow, and brown trout; and those handled in the Western Section were from rainbow, brook, and cutthroat trout.

There were 4,296,196 fry and fingerlings, valued at $87,305, sold in 1929. These were sold for stocking purposes, mostly to sportsmen. The fry and fingerlings distributed in the Eastern and Western Sections consisted largely of brook trout, while black bass were more important among the fry and fingerlings distributed in the Central Section.

Adult fish are distributed as fish for food and as fish for stocking. Sales of fish for food in 1929 amounted to 2,810,947 fish, valued at $589,554. The greater bulk of these fish were sold directly to such consumers as hotels, restaurants, and individuals, while the remainder, about one-fourth of the total, was sold to wholesale fish dealers who in turn resold to consumers. According to value, rainbow trout was the principal species of trout marketed, making up over two-thirds of the total. Most of these were marketed by hatcheries in the Western Section. Brook trout was the second species in importance in value. These were sold principally by hatcheries in the Eastern Section, although the Western Section also ranks high in sales of this species.

There were 765,924 adult fish, valued at $203,088, sold for stocking in the United States in 1929. Most of these were sold to sportsmen and sportsmen's organizations in the Eastern and Western Sections of the country. Of the total value and number, rainbow trout constituted the greatest percentage, with brook trout of nearly equal importance.

The products sold by the trout and pond fish industries in 1929 had a combined value of $1,094,144. Of this amount, the fish sold for food were valued at $589,554. Sales of eggs were valued at $214,197; sales of adults for stocking, $203,088; and sales of fry and fingerlings, $87,305. Sales of all products in the Western Section were valued at $618,884; in the Eastern Section, $386,098; and in the Central Section, $89,162.

TABLE 2.—*Distribution of eggs and fish by the trout and pond fish industries*

EGGS

Species	Sold to State or Federal Government		Sold to sportsmen		Sold to commercial hatcheries		Total	
EASTERN SECTION	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Brook trout	75,232,603	$82,817	1,753,666	$10,187	21,606,000	$16,727	98,592,269	$109,731
Rainbow trout	3,800,000	6,600			965,000	1,543	4,765,000	8,143
Brown trout					253,482	634	253,482	634
Total	79,032,603	89,417	1,753,666	10,187	22,824,482	18,904	103,610,751	118,508
CENTRAL SECTION								
Brook trout	3,909,000	5,308	2,000	2	1,080,000	1,325	4,991,000	6,635
Rainbow trout	2,700,000	4,050	200,000	400	465,000	965	3,365,000	5,415
Brown trout	1,577,000	2,616			525,000	820	2,102,000	3,436
Total	8,186,000	11,974	202,000	402	2,070,000	3,110	10,458,000	15,486
WESTERN SECTION								
Brook trout	14,155,000	16,230	795,000	1,420	4,199,000	5,371	19,149,000	23,021
Rainbow trout	7,087,500	12,980	2,080,000	4,039	17,775,000	36,795	26,942,500	53,814
Cutthroat trout	1,495,477	3,040			180,000	328	1,675,477	3,368
Total	22,737,977	32,250	2,875,000	5,459	22,154,000	42,494	47,766,977	80,203
TOTAL, UNITED STATES								
Brook trout	93,296,603	104,355	2,550,666	11,609	26,885,000	23,423	122,732,269	139,387
Rainbow trout	13,587,500	23,630	2,280,000	4,439	19,205,000	39,303	35,072,500	67,372
Brown trout	1,577,000	2,616			778,482	1,454	2,355,482	4,070
Cutthroat trout	1,495,477	3,040			180,000	328	1,675,477	3,368
Total	109,956,580	133,641	4,830,666	16,048	47,048,482	64,508	161,835,728	214,197

FRY AND FINGERLINGS

EASTERN SECTION								
Brook trout	362,000	$11,544	543,115	$17,409	65,000	$1,122	970,115	$30,075
Rainbow trout			22,707	386			22,707	386
Miscellaneous trout [1]			236,613	6,724			236,613	6,724
Miscellaneous pond fish [2]			59,286	2,688			59,286	2,688
Total	362,000	11,544	861,721	27,207	65,000	1,122	1,288,721	39,873
CENTRAL SECTION								
Brook trout			26,500	1,196	80,000	1,350	106,500	2,546
Rainbow trout	40,000	1,900	1,000	60	350,000	1,825	391,000	3,785
Largemouth black bass	69,975	3,499	290,000	13,325			359,975	16,824
Total	109,975	5,399	317,500	14,581	430,000	3,175	857,475	23,155
WESTERN SECTION								
Brook trout	752,000	6,182	611,000	5,330	90,000	750	1,453,000	12,262
Rainbow trout	70,000	699	280,000	3,958	232,000	5,808	582,000	10,465
Miscellaneous trout [1]	100,000	1,000					100,000	1,000
Largemouth black bass			10,000	500			10,000	500
Miscellaneous pond fish [2]					5,000	50	5,000	50
Total	922,000	7,881	901,000	9,788	327,000	6,608	2,150,000	24,277
TOTAL, UNITED STATES								
Brook trout	1,114,000	17,726	1,180,615	23,935	235,000	3,222	2,529,615	44,883
Rainbow trout	110,000	2,599	303,707	4,404	582,000	7,633	995,707	14,636
Miscellaneous trout [1]	100,000	1,000	236,613	6,724			336,613	7,724
Largemouth black bass	69,975	3,499	300,000	13,825			369,975	17,324
Miscellaneous pond fish [2]			59,286	2,688	5,000	50	64,286	2,738
Total	1,393,975	24,824	2,080,221	51,576	822,000	10,905	4,296,196	87,305

[1] Includes brown trout, silver trout, lake trout, and landlocked salmon.
[2] Includes smallmouth black bass, bullhead, pickerel, bluegill sunfish, crappie, and catfish.

TABLE 2.—*Distribution of eggs and fish by the trout and pond fish industries*—Con.

YEARLINGS AND ADULTS

Species	Sold to State or Federal Government		Sold to sportsmen		Sold to commercial hatcheries		Total	
EASTERN SECTION	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Brook trout	5,024	$717	279,077	$81,386	9,135	$1,857	293,236	$83,960
Rainbow trout			15,032	1,729	27,925	7,600	42,957	9,329
Miscellaneous trout [3]			28,215	3,369	950	260	29,165	3,629
Miscellaneous pond fish [4]			2,520	517			2,520	517
Total	5,024	717	324,844	87,001	38,010	9,717	367,878	97,435
CENTRAL SECTION								
Brook trout			10,200	1,640			10,200	1,640
Rainbow trout			3,000	845	23,800	2,200	26,800	3,045
Total			13,200	2,485	23,800	2,200	37,000	4,685
WESTERN SECTION								
Brook trout	15,000	2,100	10,563	1,378	133	20	25,696	3,498
Rainbow trout			329,800	96,720	2,550	525	332,350	97,245
Miscellaneous trout [3]			2,000	100			2,000	100
Miscellaneous pond fish [4]			1,000	125			1,000	125
Total	15,000	2,100	343,363	98,323	2,683	545	361,046	100,968
TOTAL, UNITED STATES								
Brook trout	20,024	2,817	299,840	84,404	9,268	1,877	329,132	89,098
Rainbow trout			347,832	99,294	54,275	10,325	402,107	109,619
Miscellaneous trout [3]			30,215	3,469	950	260	31,165	3,729
Miscellaneous pond fish [4]			3,520	642			3,520	642
Total	20,024	2,817	681,407	187,809	64,493	12,462	765,924	203,088

[3] Includes brown trout and lake trout.
[4] Includes catfish, pickerel, yellow perch, bluegill sunfish, and crappie.

TABLE 3.—*Distribution of fish for food by the trout and pond fish industries in the United States, 1929*

Species	Eastern Section				Central Section			
	Sold to hotels, restaurants, dining cars, individuals, etc.		Sold to wholesale and retail dealers		Sold to hotels, restaurants, dining cars, individuals, etc.		Sold to wholesale and retail dealers	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Brook trout	166,597	$50,366	303,521	$79,160	35,167	$8,036	427	$149
Rainbow trout	1,545	756			148,175	30,802	24,426	6,049
Miscellaneous [1]					3,200	800		
Total	168,142	51,122	303,521	79,160	186,542	39,638	24,853	6,198

Species	Western Section				Total				
	Sold to hotels, restaurants, dining cars, individuals, etc.		Sold to wholesale and retail dealers		Sold to restaurants, hotels, dining cars, individuals, etc.		Sold to wholesale and retail dealers		Total sales
	Number	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Brook trout	157,137	$33,426	24,205	$3,857	358,901	$91,828	328,153	$83,166	687,054	$174,994
Rainbow trout	1,653,125	315,429	280,322	59,984	1,802,845	346,987	304,748	66,033	2,107,593	413,020
Miscellaneous [1]	13,100	740			16,300	1,540			16,300	1,540
Total	1,823,362	349,595	304,527	63,841	2,178,046	440,355	632,901	149,199	2,810,947	589,554

[1] Includes yellow perch, bluegill sunfish, catfish, and brown trout.

TABLE 4.—*Summary table showing the products distributed by the trout and pond fish industries in the United States, 1929*

Products	Eastern Section		Central Section		Western Section		Total	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Eggs	103, 610, 751	$118, 508	10, 458, 000	$15, 486	47, 766, 977	$80, 203	161, 835, 728	$214, 197
Fry and fingerlings	1, 288, 721	39, 873	857, 475	23, 155	2, 150, 000	24, 277	4, 296, 196	87, 305
Adults (and yearlings) for stocking	367, 878	97, 435	37, 000	4, 685	361, 046	100, 968	765, 924	203, 088
Adults (and yearlings) for food	471, 663	130, 282	211, 395	45, 836	2, 127, 889	413, 436	2, 810, 947	589, 554
Total	105, 739, 013	386, 098	11, 563, 870	89, 162	52, 405, 912	618, 884	169, 708, 795	1, 094, 144

GOLDFISH INDUSTRY [3]

The goldfish industry commands an important position among the fish-farming industries of the United States. The principal centers of the industry are in Maryland, Ohio, and Indiana, but many small farms are scattered throughout the country.

The production of goldfish in 1928 amounted to 21,500,000 fish, having a value to the breeders of about $942,000. This consisted of 17,000,000 common goldfish valued at $573,000, and 4,500,000 fancy goldfish valued at $369,000. The value was arbitrarily based on the price received by the producers for the common and comet varieties.

In 1928 there were about 770 acres of ponds in the United States devoted to the culture of goldfish. These ponds ranged in size from one-fourth of an acre to 10 acres. They were supplied with water from streams, springs, and wells, and with rain water. It costs from $50 to $1,000 an acre to build such ponds, depending upon the type of ground upon which they are constructed. The usual cost, however, is $150 to $200 per acre.

Most of the goldfish are shipped from September until the last of May. During the summer it is too warm to ship very many fish in each can and therefore the cost of shipping them is considerably higher. The fish are shipped in large galvanized cans that hold from 100 to 1,000 fish, depending upon their size, the distance to be shipped, and the weather.

Most of the goldfish to-day are handled by the 5-and-10 cent stores and by drug stores as an advertising feature. Pet shops in most of the large cities still carry them, however, and sell considerable numbers.

TOTAL VALUE OF PRODUCTS MARKETED BY THE FISH-FARMING INDUSTRIES

The total value of products marketed annually by the fish-farming industries in the United States is $2,036,144. This figure is the combined annual value of products marketed by the goldfish industry, which in 1928 amounted to $942,000; of products marketed by the trout industry, which in 1929 amounted to $1,072,700; and of products marketed by the pond-fish industry, which amounted to $21,444 in 1929.

[3] The material appearing under this subject was obtained from Fisheries Economic Circular No. 68 entitled "Goldfish Industry," by Thomas Quast (1929).

METHODS

TROUT-FARMING METHODS[4]

Water supply.—Springs and streams constitute the water supplies used by commercial trout hatcheries, but generally when streams are used they are operated as auxiliary water supplies. Water supplies are always tested as to their suitability, and even if adaptable, they may become unsuitable through pollution or disease.

Equipment.—As the Bureau of Fisheries has been a pioneer in the practice of fish culture in the United States, and as its activities in this line are more widespread than those of any other agency, a large proportion of the hatcheries were built and are operated in the same way as those built and operated by the bureau. While a large

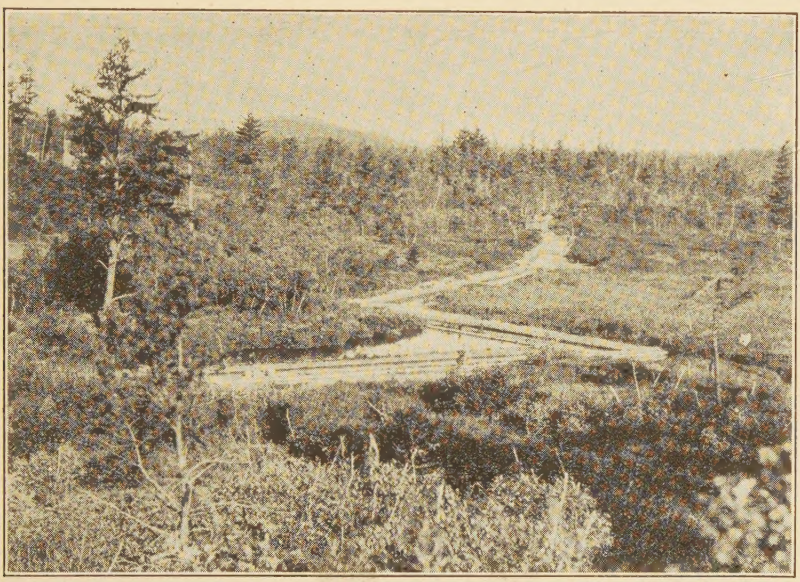

FIGURE 2.—Trout ponds constructed under semi-natural conditions. Note how these ponds follow the natural bed of the stream

number of structural variations are noticeable, such variations are productive of the same results as those obtained by Government hatcheries, and require the same methods in operating. The hatchery equipment consists of troughs through which water is run at a certain depth, and in which wire egg trays or baskets are suspended. The wire in the trays or baskets is such that when the eggs hatch, the fry can fall between the strands of the wire onto the floor of the trough. The floor of the trough is divided so that the fry are kept from crowding. Many variations are used in the methods of suspending the eggs in the troughs, but the chief requisite is a stream of suitable running water in contact with the eggs.

In the trout industry, ponds vary in size so much that no special size can be stated as being necessary. The ponds should be small enough so that they may be seined easily and should be capable of partial or total drainage. Earthen, wood, and concrete ponds are used in all sections of the country.

[4] Full details regarding the locating of the trout hatchery and of construction of ponds, with methods of handling trout, are described in Bureau of Fisheries Document No. 955 entitled "Artificial Propagation of Brook Trout and Rainbow Trout, with Notes on Three Other Species" by Glen C. Leach.

Production methods.—When the brood fish are spawned the fertilized eggs are placed in trays in the hatchery. Dead eggs are removed to avoid infection of the living eggs. Each fry has been provided by nature with a yolk sac which supplies food until the fish is able to take artificial food. When the yolk sac is absorbed, or later, depending on the practice of the culturist, the fry are moved to outside "fry ponds," which are usually smaller than the ponds in which the yearling and adult fish are held. Artificial food consists of ground beef liver for the fry, but the high price of this food forces the fish culturist to seek other foods for his older fish. Other foods are introduced after the fry are well started feeding on beef liver. Horse meat from wild horses; lungs, hearts, livers, and spleens from hogs, sheep, and cattle; herring; spawned-out salmon; shrimp meal; buttermilk; and

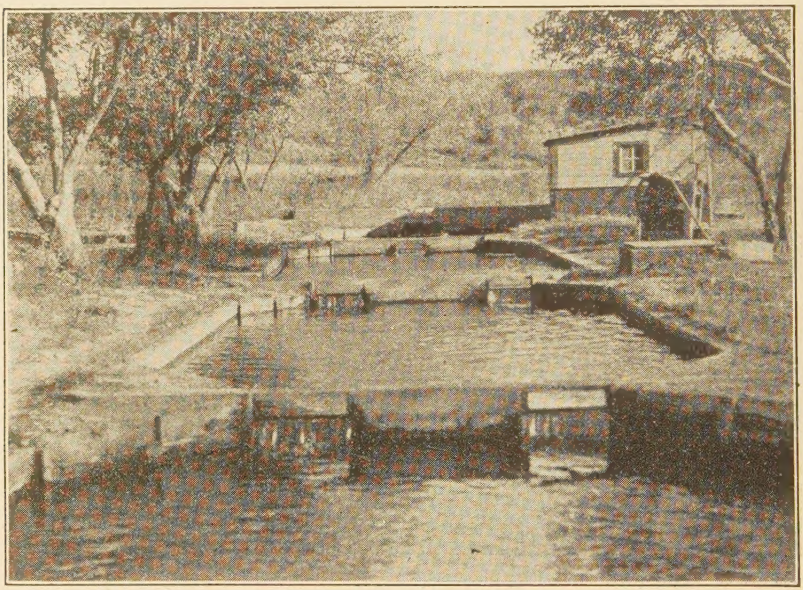

FIGURE 3.—A series of wide trout fry ponds

dried milk are all used with success. Another food consists of dried salmon eggs, which was being used experimentally in 1929. In preparation these are often mixed with varying quantities of beans, wheat middlings, and cod-liver oil and are fed both raw and cooked. Fish of similar sizes are kept together, and the giants and runts are graded out at set intervals.

Diseases are diverse and many. They are apt to appear at any time when aided by favorable conditions and often cause the greater part of the losses experienced by the culturist. Clean hatchery equipment and ponds are the best safeguards against disease, while in many hatcheries eggs and fish are treated with salt and acetic-acid solutions regularly to guard against disease. In Fisheries Document No. 1061, entitled "Care and Diseases of Trout," Dr. H. S. Davis describes the appearances and treatments of the more common ailments.

In addition to disease, natural enemies are important factors in the loss of fish. Kingfishers, herons, bitterns, crows, sea gulls, and wood

ducks are all tremendously destructive, while rats and snakes add to the loss.

There are variations in the rates of growth of trout in all hatcheries. Growth varies with feed, temperature of the water, species of fish, and with the chemical and physical character of the water itself. Trout are usually ready for market as food fish (2 to 6 to a pound) in from 12 months to 2 years after hatching. Then, if not sold for food, they are kept for brood stock or are sold for stocking public or private waters. Trout are also sold for stocking purposes when they are in the fry and fingerling stages. Brook trout spawn for the first time when 2 years old, but eggs are not taken from any of the trout as a general practice until the fish are 3 years of age.

Shipping methods.—For transporting eggs special containers are used. There is much variation in the structure of these containers,

FIGURE 4.—A series of narrow trout fry ponds with wooden sides

but in general they consist of an outside insulating casing with a hinged cover, said casing usually made of wood lined with cork, and an inside box in which the eggs are packed in single layers on trays. To keep the temperature constant and the eggs moist an ice tray is placed on top of the egg trays, and the ice tray is refilled at points along the route of shipment. In operation the ice melts cooling the container, and the water dripping down over the eggs keeps the shells moist, while moss serves to retain the moisture. The excess water drains out of the box through holes in the bottom of the container.

Another method used to a limited extent in transporting trout eggs for short distances is the method of bulk packing, where the eggs are packed in a mass instead of in single layers on trays. For this method square frames 2 to 3 inches deep are used. These frames are divided into four compartments and have the bottom side covered with fine-mesh wire or muslin. The eggs are packed in the compart-

ments in damp moss. The frames are then packed in the same kind of a casing as are the trays, with an ice tray on top. Eggs are packed at the hatchery, shipped by express, reiced at prearranged points and received at their destination, where they are unpacked and carefully acclimated to any change in temperature.

Fish transported alive are shipped almost entirely in 5 to 10 gallon cans on motor trucks. Air is provided to the water through surface aeration and splashing. Oxygen tanks and air pumps to supply oxygen and air to the water are safer, however, and are used, when available, for trips over 100 miles.

Trout to be used as food are shipped mainly in the round by express. They are packed in ice in wooden boxes that hold about 30 pounds of

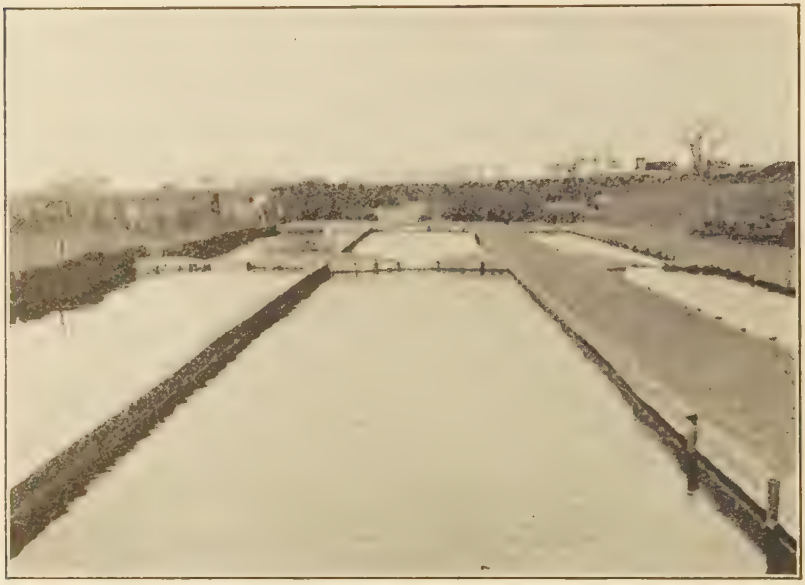

FIGURE 5.—Parallel ponds for adult trout

fish. In a few localities the trout are eviscerated before shipping, and in a few localities the fish are partially protected from the melting ice by layers of paper or other materials.

Distribution methods.—Distribution of eggs and of fingerlings, fry, and adults for stocking is accomplished through the efforts of the individual hatchery man. Up to 1930 there has been little difficulty in selling these products and no special sales efforts have been necessary. Some hatcheries have had orders for their total production on file for several years in advance. The volume of the sales is determined by the stock on hand, and the policy of all commercial trout hatcheries calls for the sale of all surplus eggs and fish. In this way all equipment is kept in use and overcrowding is avoided.

The distribution of trout for food in the United States is managed mainly by the individual hatchery. Other sales agencies include two cooperative organizations and several salesmen for individual hatcheries. Approximately half of the fish marketed are sold direct to the consumer at the hatchery, while the rest of the trout are shipped to wholesale dealers, hotels, restaurants, dining cars, and individuals.

With present marketing methods most of the trout are eaten within 24 hours after leaving the water. In this way the consumer has been assured of a fresh product.

Trout for food are sold as specialties, as the cost of production is high and the risk is great. They are popular for banquets, in restaurants, and in the dining rooms of high-class hotels and resorts. Dining cars throughout the Southwestern part of the United States are noted for their trout dinners. Names used by the trout industry, such as "Eastern brook trout" and "Rocky Mountain rainbow trout," try to describe the desirability of these fish. Numerous restaurants display live trout in aquaria in their windows. Diners are there enabled to select the trout they wish and have it cooked for them.

A large number of hatcheries sell to anglers, who catch the fish in the hatchery ponds with hook and line. After being caught the fish are

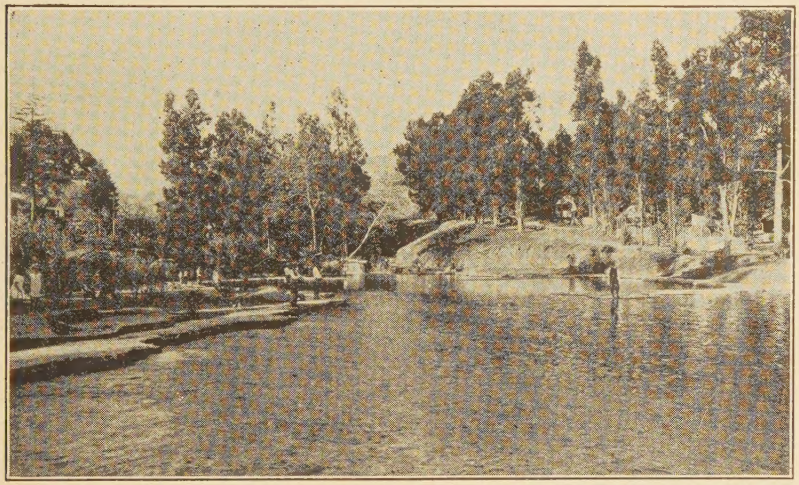

FIGURE 6.—This lake is operated in conjunction with a trout hatchery. Note the anglers fishing from the bank

weighed, eviscerated, wrapped by the attendant, and taken home by the angler. A few of these establishments are equipped to cook the fish as they are brought in. Such hatcheries have lunch-room, picnic, or fish-dinner facilities and may have recreational equipment operated in conjunction with the fish hatchery.

Many trout are sold in the round to consumers at the hatchery. To care for this business the proprietor of the hatchery keeps the proper-sized trout available in a small pond, where wire boxes, such as shown in Figure 7, are frequently used to hold the fish prior to sale. The fish are removed by dip net. They are then weighed, sometimes cleaned or eviscerated, and wrapped for the customer.

On the Pacific coast, in the Mississippi River region, from the Great Lakes south to St. Louis, and in the North Atlantic States, all large cities are served by the trout industry. While a large number of concerns are still operating on an experimental basis, a few years will tend to stabilize production and will undoubtedly allow the products to become better known through larger sales and advertising.

POND FISH FARMING METHODS [5]

Water supply.—Ponds form the natural habitat of pond fishes or warm-water fishes. In the pond-fish industry these are formed artificially by excavation or dyking or by a combination of both. Temperature requirements are higher than in the trout industry, and thus they naturally confine the industry to a region further south. In contrast to trout ponds, ponds for warm-water fish should have a minimum of water flow and need only enough water added to compensate for drainage and evaporation.

Production methods.—Brood stocks are planted in the ponds and allowed to propagate naturally. There they build nests and lay their eggs. After hatching, the brood stock may be removed, or the young fish may be removed. In such cases, the young fish are isolated in a

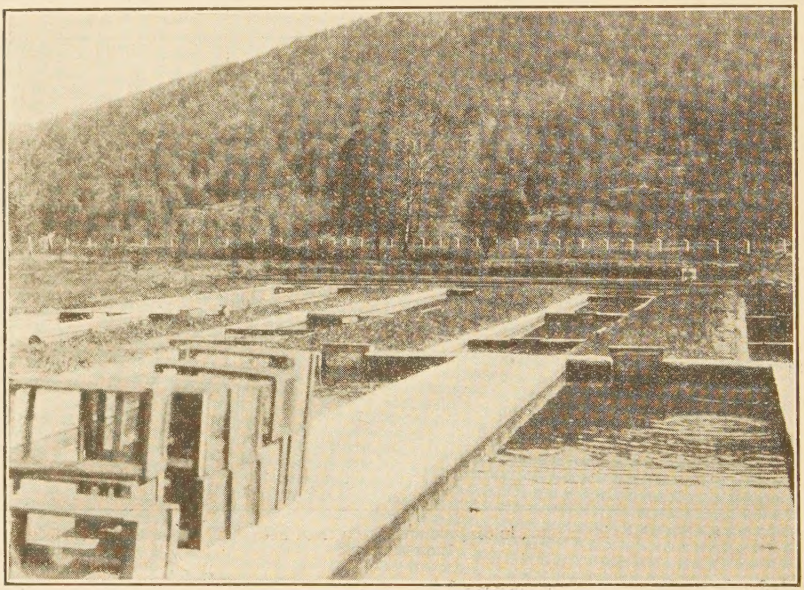

FIGURE 7. Parallel trout ponds, constructed of brick and concrete, showing boxes used for holding trout alive preliminary to shipping

pond or in ponds where there is plenty of plant growth and there they find their own food. If enough food is not present naturally, extra food may be provided artificially. Under favorable conditions the fish will develop rapidly and need be disturbed only when sorting or for removal. For the purposes of sorting or removing fish or killing vegetation the pond is drained. This crowds the fish into a small volume of water and facilitates their removal with dip nets or seines. If the fish are to be shipped to other waters, they are placed in large cans of water similar to those for trout and transported in trucks or by rail. Shipments of this nature are often en route up to two days. Messengers are usually sent along with these shipments to care for the fish and aerate the water. To prevent fouling of the water the fish are not fed for several days before shipping.

[5] Propagation of pond fishes is described in "Propagation of pond fishes" by M. C. James, Fisheries Document No. 1056; and in "Experiments in the culture of the black bass and other pond fish" by H. S. Davis and A. H. Wiebe, Fisheries Document No. 1085.

Distribution methods.—Sales of pond fishes are handled by the producer. At the present time very few pond fish are sold in the round or eviscerated condition for food, as there is always a good demand for them for stocking private and public waters where they may be taken later by an angler. As there are fewer pond-fish producers than there are trout producers and they are less scattered over the United States, shipment of pond fish generally travel much greater distances to market than do shipments of trout. Consequently, unit transportation costs are greater in the pond-fish industry than in the trout industry.

GOLDFISH-FARMING METHODS

Methods used in commercial goldfish production are described by Thomas Quast (1929) in Fisheries Economic Circular No. 68, entitled "Goldfish Industry." In general, they are farmed much like the pond fishes, propagation of which has been described in this report.

FISH-RAISING INDUSTRIES

In addition to the fish farmed in the trout, pond fish, and goldfish industries, carp and buffalofish also are raised commercially. While it is possible to propagate these species of fish, this is not done commercially in the United States to any appreciable extent. However, quantities of these fish are obtained from natural sources and impounded pending sale. While being held these fishes are fed whole shelled corn to fatten them and to increase the firmness of their flesh. These are marketed in the round, or eviscerated, and also alive in the larger population centers of the United States.

Railroad cars used in transporting carp and buffalofish alive are supplied with tanks, which are filled with water, the water being aerated by pumps attached to the car's axle. The fish are transported from the railroad cars to retail stores by trucks equipped with tanks. At the retail dealer's establishment they are held alive in tanks supplied with running water until they are sold.

New York City is the chief market for live buffalofish and carp, although considerable quantities are sold in St. Louis and other large cities, which have equipment for handling live fish. These fish come from points on the Great Lakes (notably Lakes Huron and Erie) and points in the Mississippi River region.

Some idea of the potential market for live carp and buffalofish may be gathered from the fact that over 5,000,000 pounds were sold in New York City alone in 1924 (Fiedler, 1926). A conservative estimate places the annual consumption of carp and buffalofish from feeding ponds and natural sources in the United States at 40,000,000 pounds, with a value of $2,000,000.

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U. S. GOVERNMENT PRINTING OFFICE: 1931

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